RESEARCH, DEVELOPMENT & TECHNOLOGY TRANSFER
QUARTERLY PROGRESS REPORT

Wisconsin Department of Transportation
DT1241 02/2011

INSTRUCTIONS:
Research project investigators and/or project managers should complete a quarterly progress report (QPR) for each calendar quarter during which the projects are active.

WisDOT research program category: ☐ Policy research ☒ Wisconsin Highway Research Program ☐ Other ☐ Pooled fund TPF#		Report period year: 2012 ☐ Quarter 1 (Jan 1 – Mar 31) ☐ Quarter 2 (Apr 1 – Jun 30) ☒ Quarter 3 (Jul 1 – Sep 30) ☐ Quarter 4 (Oct 1 – Dec 31)
Project title: Aesthetic Coatings for Bridge Components		
Project investigator: Dr. Al Ghorbanpoor	Phone: 414-229-4962	E-mail: algh@uwm.edu
Administrative contact: Nikki Hatch	Phone:	E-mail:
WisDOT contact: Travis McDaniel	Phone: 608-266-5097	E-mail: travis.mcdaniel@dot.state.wi.us
WisDOT project ID: 0092-11-07	Other project ID:	Project start date: 10/21/2010
Original end date: 10/20/2012	Current end date: 08/31/2013	Number of extensions: 1

Project schedule status:
☒ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Project budget status:

Total Project Budget	Expenditures Current Quarter	Total Expenditures	% Funds Expended	% Work Completed
$145,000.00	$11,000.00	$119,000.00	82%	80%

Project description:

The objectives of this study are to investigate methods and products that may be used in the aesthetic and protection coating of bridge components and to develop a guideline for cost-effective bridge coating practices. It was envisioned that a series of coating systems for both steel and concrete would be identified and tested in the laboratory to evaluate their performance under simulated environmental conditions that are similar to those experienced by bridge components in Wisconsin. After conducting a preliminary investigation and holding discussions with the Project Oversight Committee (POC), it was approved by the POC that the focused should be placed on evaluation of only steel materials due to the extensive nature of the required investigation and scope of the current study. Wisconsin bridge sites, where coating failures and problems have occurred, have been visited to identify and evaluate the structural details and other factors that have contributed to such coating failures. Upon completion of the testing and evaluation program, guidelines and specifications language will be developed for selection, application, and maintenance of such coating materials. Also, recommendations will be made to WisDOT for implementation of the results of this study.

Progress this quarter (includes meetings, work plan status, contract status, significant progress, etc.):

During this quarter the research staff has continued the Freeze/UV/Prohesion and Xenon Arc testing. Nine cycles of Freeze/UV/Prohesion have been completed at this point. A cycle of Freeze/UV/Prohesion consists of a 24-hour freeze, one week in UV chamber, and one week in salt-fog chamber. Fifteen cycles of Xenon Arc testing have been completed on the black (Federal Color Number 27038) 2"x2" colored samples, and xenon arc testing has begun on the blue (Federal Color Number 15092) colored samples. To date, five cycles have been completed on the blue colored samples. An evaluation of the differences in change in color (ΔE) and gloss for black samples compared to the blue samples will be made at the completion of the xenon arc testing. This comparison will determine if one of the colors has a tendency to have greater change in color than other. A cycle of Xenon Arc consists of one week in the Xenon Arc chamber with repeating 2-hour cycles of 1 hour and 42 minutes of Xenon light and 18 minutes of Xenon light with water spray.

At the end of each cycle of Freeze/UV/Prohesion the 3"x6" samples are measured for changes in color (ΔE) and gloss, rust creepage, holidays, and dry film thickness. The 4"x6" samples in the Freeze/UV/Prohesion are used to measure the change in flexibility from the control samples to the weathered samples. For each cycle, the 2"x2" samples in the Xenon Arc testing are measured for change in gloss (ΔE) and color, and dry film thickness. When evaluating the blue colored samples not only is the overall change in color (ΔE) evaluated, but also the change in the (b) value in the L-a-b color indexing system. The change in the (b) values looks specifically on how the just blue in the coating is changing.

Additionally, the research staff has been conducting pencil hardness test on the 3"x6" control samples and flexibility test on the 4"x6" control samples. Pencil hardness was measured following ASTM D3363-05: "Standard Test Method for Film Hardness by Pencil Test". To determine a measure of coating hardness, the test is conducted with pencils of varying hardness until the hardest pencil that will not cut into or gouged the coating for a stoke of at least 1/8 inch is found. The pencil that meets the prior criteria determines the pencil hardness of a specific coating. The pencils are placed in a pencil hardness testing device, shown in Figure 1. This testing device allows for the pencil to be placed at a 45° angel with respect to the sample, and also allows for a uniform pressure to be applied.

Figure 1: Pencil Hardness Tester

Coating flexibility was measured following ASTM D522-93a (Re-Approved 2008): "Mandrel Bend Test of Attached Organic Coatings". To conduct the flexibility testing, a conical Mandrel Tester with a cone ranging from 0.125 inches in diameter at one end to 1.5 inches at the other end was used as shown in Figure 2. This test was performed on the 4"x6" test samples. When conducting the test, the samples are secured in the Mandrel Tester and then the lever is moved 180° at a uniform velocity. The test duration for each sample is approximately 15 seconds. Cracks may be initiated in the coating from the area near the small end of the mandrel that extend toward the larger end of the mandrel. Upon completion of the test, each crack length is measured and the percentage of elongation is determined. The control pencil hardness tests and the flexibility tests will be compared to the pencil harness on the weathered 3"x6" and the flexibility on the weathered 4"x6" samples upon testing completion.

Figure2: Conical Mandrel Tester

For the Freeze/UV/Prohesion test, it is too early in the test to predict a trend in behavior but to date, both the powder coated and liquid coated fluoropolymer samples show the best performance with the lowest ΔE, with the polyurethane coatings being the next best performers. The mid-grade duplex polyester powder coating system and one of the two coat systems are experiences the highest ΔE values and the fading in the color of these samples are visually noticeable. The second two-coat system exhibits a ΔE that is slightly higher than all coating systems in the test program except one of the polyurethane coatings. Most of the non-galvanized samples have started showing rust creepage about the scribe. To date, all of the blue samples in the xenon arc testing have shown a higher ΔE value compared to the first five cycles of xenon arc testing on the black samples.

Anticipated work next quarter:

The research staff will continue the test program on all the selected coated samples. During the testing phase, the coated samples will be subjected to two different tests. One test will consist of Freeze/UV/Prohesion cycles and the other test will consist of the Xenon Arc testing. The test panels will be evaluated every two weeks for the effects of the Freeze/UV/Prohesion test and every week for the effects of the Xenon Arc testing. The bi-weekly and weekly evaluation will include measuring changes in color and gloss, rust creepage, holidays, and dry film thickness for the test samples. Samples will also be photographed bi-weekly for Freeze/UV/Prohesion test program and weekly for Xenon testing.

Circumstances affecting project or budget:

None.

Attach / insert Gantt chart and other project documentation

Quarters/Tasks	1	2	3	4	5	6	7	8	9	10	11
1. Literature Review	_____										
	----------										
2. Survey	_____										
	---------										
3. Interim Report	_____										
	----------										
4. Laboratory Testing			_____								
			----------								
5. Future Research						_____					
						----------					
6. Guidelines/Specs						_____					
						----------					
7. Draft Final report								_____			
8. Final Report										_____	

FOR WISDOT USE ONLY

Staff receiving QPR:	Date received:
Staff approving QPR:	Date approved:

Test Program
(Approved by POC on September 22, 2011)

Aesthetic Coatings for Bridge Components

WHRP Project # 0092-11-07

By

Al Ghorbanpoor and Zan Leppi
University of Wisconsin-Milwaukee

September 26, 2011

Introduction

To meet the requirements of the current WHRP study entitled "Aesthetic Coatings for Bridge Components," the research team submitted a proposal on September 14, 2011 to the Project Oversight Committee (POC) and WHRP to seek approval for the proposed testing program to be performed during the remaining term of this study. The proposal included two options which were both limited to testing coating systems for only new steel applications. The proposed options included a testing program of either 10 or 12 coating systems under two color schemes. The program as approved by the POC includes the 12-coating system option that consists of a slightly smaller number of test samples for the Xenon and Mandrel testing components. Through a correspondence on September 22, 2011, the POC forwarded to the research team a final approval for the test program as detailed below.

Approved Coating Systems and Test Program

The following table shows 12 coating systems for new steel applications, along with the number of samples, and the type of tests that will be performed on these coating systems. A description of each coating system is shown in appendix "A". There will be 5 samples per coating system for the UV/Prohesion/Freeze tests (Alternate ASTM D5894), and 2 samples per coating system for Mandrel testing. For Xenon testing, there will be 3 samples per coating systems tested with the following exception. The top-coats for coatings systems #A and #M and for #C and #N are the same so we will achieve the same results by performing tests on only coating systems #A and #C. Accordingly, we will eliminate the Xenon tests for coating systems #M and #N, to meet the space limitation of the Xenon testing equipment. For all UV/Prohesion/Freeze and mandrel tests, the Federal Color Number (27038) black will be used. For the Xenon tests, the Federal Color Number (27038) black and Federal Color Number (15092) blue will be used. Accordingly, a complete Xenon testing program of a minimum of 1,000 hours will be performed for samples coated with each selected color.

Approved 12 Coating Systems

System Type and #	Number of Systems	# of 3x6x1/8 in. Samples for UV/Prohesion/Freeze Testing (Alternate ASTM D5894)	# of 2x2x1/8in. Samples for Xenon Testing (ASTM G155)	# of 4x6x1/32in. Samples for UV/Prohesion/Freeze Mandrel Testing[2]
3-Coat Polyurethane (#A, #C, #Y)	3	15	9	6
3-Coat Fluoropolymer (#B, #Z)	2	10	6	4
2-Coat (#F, #0)	2	10	6	4
Galvanized Paint (#M, #N, #X)	3	15	3[1]	6
Galvanized Powder (#AA, #AB)	2	10	6	4
Total	12	60	30	24

[1] Tests applies to coating system #X only. Note that top coats are the same for coating #A and #M and for #C and #N.

[2] 2 samples per coating system will be tested under the Mandrel tests.

Appendix "A"
(Description of Coating Systems)

3-Coat Polyurethane Systems

Coating #	Manufacture	3-Coat System	Primer /DFT(mils)	Intermediate Coat /DFT(mils)	Top Coat /DFT(mils)
A	Sherwin Williams	Polyurethane	Zinc Clad III /(3-6)	Macropoxy 646 /(3-10)	Acrolon 218 HS /(3-6)
C	Carboline	Polyurethane	Carbozinc 859 /(3-5)	Carboguard 888 /(3-5)	Carbothane 133LH /(3-5)
Y	PPG	Polyurethane	Amercoat 68HS /(3)	Amercoat 399 /(4-8)	Amercoat 450H /(2-5)

3-Coat Fluoropolymer Systems

Coating #	Manufacture	3-Coat System	Primer /DFT(mils)	Intermediate-Coat /DFT(mils)	Top-Coat /DFT(mils)
B	Sherwin Williams	Fluoropolymer	Zinc Clad III /(3-6)	Macropoxy 646 /(3-10)	Fluorokem /(2.5-3)
Z	Carboline	Fluoropolymer	Carbozinc 859 /(3-5)	Carboguard 888 /(3-5)	Carboxane 950 /(2-3)

2-Coat Systems

Coating #	Manufacture	1st Coat/DFT(mils)	2nd Coat /DFT(mils)
F	Carboline	Carbozinc 859 /(5-7)	Carboxane 2000 /(7)
O	Sherwin Williams	Corothane I Galvapac Zinc /(3-4)	Polysiloxane XLE-80 /(3-7)

Galvanized Systems with Paint Coats

Coating #	Manufacture	Tie-Coat/DFT(mils)	Top-Coat/DFT(mils)
M	Sherwin Williams	Macropoxy 646 /(2-4)	Acrolon 218 HS /(2-4)
N	Carboline	Galoseal WB /(0.5-1)	Carbothane 133LH /(3-5)
X	Wasser	MC-Ferrox B 100 /(3-5)	MC-Luster 100 /(2-4)

Galvanized Systems with Powder Coat

Coating #	Manufacture	Tie-Coat/DFT(mils)	Top-Coat/DFT(mils)
AA	Sherwin Williams	EAS6-C000 Epoxy /(1.8-3)	AAMA 2605 Fluoropolymer /(2-3)
AB	Sherwin Williams	EAS6-C000 Epoxy /(1.8-3)	AAMA 2604 Polyester /(2-3)